

VOLUME II

HVAC SYSTEM

HVAC SYSTEM OF FANIDHAR MEGA FOOD PARK: PARK: CP AREA

OWNER



FANIDHAR MEGA FOOD PARK
MUDARDA, MEHSANA

CONSULTANT



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1. SCOPE OF WORK FOR HVAC SYSTEM

- 1.1 The scope of work shall include the Supply, Installation, Erection, painting, packing & forwarding, Testing and Commissioning of HVAC system as per the BOQ enclosed along with this document.
- 1.2 Unloading, shifting, erection & commissioning assistance for HVAC equipment as per enclosed BOQ along with this document.
- 1.3 Preparation of good for construction & As built drawings as per scope of work.
- 1.4 Preparation of Design Calculations, data sheets, erection philosophy and other relevant documents
- 1.5 Shop Drawings/documents & As Built Drawings 5 sets bound in a standard/readable size in Folder with Indexing. 2 Set in Soft Copy (auto cad+pdf format)
- 1.6 Operation & Maintenance manual 3 sets (1 original+ 2 copy) bound in a standard size folder with indexing and proper labelling. 2 Set in Soft Copy (auto cad / Word / Excel +pdf format)
- 1.7 Arrangement for labour, tools & tackles, erection equipment and necessary materials required for completion of work as per the tender document.
- 1.8 The Scope also covers design, supply, fabrication and erection of pipe supports including shoes, guides, stops/anchors, clips, cradles, hangers, turn-buckles, supporting fixtures, brackets, cantilever structural, tee posts, etc.
- 1.9 Final painting/labelling of approved shade of all piping, Valves, supports etc. Marking of direction of flows and labeling of piping etc would be done on pipe line as detailed out in subsequent clauses of this document.
- 1.10 Earthing of all equipment as per relevant Indian standards.
- 1.11 All statutory approval & third-party inspection as required to complete the assigned work.
- 1.12 Arrangement for utilities required for CONTRACTOR shall be as per Vol I of this tender.
- 1.13 CONTRACTOR shall submit a detailed write-up on how he proposes to plan his work, manning program and bio-data of key personnel he proposes to deploy at site and tools and tackles he proposes to deploy at site.
- 1.14 Spare Parts required for 1-year normal maintenance (specified List to be submitted by Supplier along with tender and the same would be finalised)
- 1.15 Site supervision, safety in charge and labours to carry out works on 24-hour basis with the Prior permission of Engineer In charge
- 1.16 Approval for Sub contractor and Engineers to be deployed at site for erection/commissioning would be taken only after approval from CLIENT/CONSULTNAT.

2. INSTRUCTIONS TO BIDDER

- a) Bidder shall submit the list of jobs intended to be sub-contracted along with the details of sub bidders. The bidder in the event of his tender being accepted, shall not assign or delegate the contract or any part thereof, without the prior approval of CLIENT/CONSULTANT.
- b) It will be the sole responsibility of the bidder to ensure that they abide by the various rules and regulations, bye-laws and other statutory requirements, etc., imposed by the Government / semi-Government and / or other local authorities governing execution of this job.
- c) Before submitting the bid, the bidder is advised to visit, inspect and examine the site and its surroundings. The bidder to look at access to the site and evaluate the site conditions of operation at his own cost. The bidder before tendering should clearly understand the scope of work and must satisfy himself with the required quantities of material, accommodation as may be required and no claim subsequently on account of ignorance shall be entertained. No consequent extra claims on any misunderstanding or otherwise shall be allowed by CLIENT.
- d) Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. Bidder's offer should specifically mention any clarifications, deviations, interpretations and/or assumptions required.
- e) The bid shall be evaluated as complete package and not on the basis of individual items.
- f) The quoted rates of each item shall remain firm.
- g) The bidder will have to make his own arrangement to transport the required materials outside and inside the working place and leaving the premises in a neat and tidy condition after the completion of the job to the satisfaction of CLIENT.
- h) The bidder will have to arrange for site office and temporary shed on his own expense for safe keeping of his materials and should provide necessary security arrangements for safe guarding the materials. CLIENT will not be responsible for any claims in this regard.
- i) The bidder shall get prior approval from CONSULTANT /CLIENT for release of purchase order to sub-vendors and bidders.

- j) The bidder shall furnish to the CONSULTANT /CLIENT the duplicate copies of all purchase orders placed for this project and the test reports received from the vendor to the CONSULTANT's check and information.
- k) The bidder shall arrange at his own expense for concerned Engineers to attend pre-bid meetings, technical discussions and project progress review scheduled by CONSULTANT /CLIENT. The venue for the meetings will be at CONSULTANT's office or at the project site.
- l) All material constructed or otherwise, shall be considered as the property of bidder till the handover of the project.

2.1 QUANTITY MEASUREMENT

- 2.1.1 The quantities of work shown in the tender schedule may vary during actual execution of work; so, payment shall be made as per actual measurement. The contractor is not entitled for any sort of compensation towards material procured/stored in excess of the measured and authorized quantities, whichever is less.
- 2.1.2 The Client reserve the right to increase or decrease the tendered quantity or replace specifications, drawings, design of any or every item or delete them at any stage of work. The contractor's claim for compensation or damages on account this shall not be entertained. Such deviation shall be adjusted at the rates contained in the contract or arrived at by calculation from contract rates.
- 2.1.3 Detailed measurement of the work carried out shall be taken jointly by the Contractor and Client/Site-in-Charge at every stage of work before proceeding to the next stage of work and shall be measured as per procedure laid down and payment shall be made as per measured quantities, subject to their conforming to the quantities ordered as per drawing/schedules and not as per tender schedule quantities.

2.2 TIME FOR COMPLETION OF WORK

The timeframe considered shall be as per Vol I, of this tender.

2.3 STOPPAGE OF WORK

In case it becomes necessary for the Client to temporarily suspend or postpone the work partly or fully due to unforeseen circumstances, Client shall not be liable for any compensation on account of the resultant delay.

2.4 INSPECTION AND TESTING

MATERIALS

- 2.4.1 All materials required for the execution of the work should conform to the standard specification and approved by the Client/Site-In-Charge before plant commissioning.
- 2.4.2 Commencement of work without prior approval shall be entirely at the risk and cost of the Contractor. No delay due to non-availability of the materials, tools, equipment, etc. will be entertained by the Client. In case of certain machinery/equipment, the Client/Site-in-Charge may inspect the item for approval before they are brought to site.
- 2.4.3 The Client/Inspector or any agency authorized by Client shall be entitled at all times at the risk of the Contractor to inspect and / or test or direct the Contractor to test any item supplied or proposed for supply for incorporation in the works and / or any work done by the contractor. Necessary assistance for this will be provided by the Contractor and all the expenses incurred in such testing / inspection will be borne by the Contractor.
- 2.4.4 The contractor shall on receipt of intimation or any communication from Client of any inspection or tests required to be carried out by the Client on his behalf, present himself or his authorized representative at the place of inspection and / or testing to receive an order or instruction consequent thereto as shall be necessary.
- 2.4.5 The Contractor shall furnish, to the Client/site-in-charge for approval when requested or as required by the specification or other contract documents, adequate samples should be submitted before the work is commenced as also permit sufficient time to the Client for tests, examination(s) thereto by the Client. All materials finished and incorporated in the works shall conform to the approved sample(s) in all respects.
- 2.4.6 The Site-in-charge shall be entitled to reject at any time any defective material supplied and /or work done by the contractor for incorporation in the works notwithstanding previous inspection and / or testing Upon such a rejection, the Contractor shall either perform such work again or improve thereon and inspect thereof as shall be necessary to bring the material to the requisite standard or if so required by the Site In charge
- 2.4.7 Test certificates including test records, performance curves and balancing certificates shall be supplied according to the Distribution Schedule.

WORKS

- 2.4.8 The contractor, at all time, shall ensure highest standard of workmanship, relating to the work to the satisfaction of the Site-in-Charge. The site-in-charge shall have the power to inspect the work in all respect at all times up to the completion of the work as also to test or give instruction to the contractor to test the works or any structure material or component thereto at the risk and cost of the contractor, either by the contractor or by any agency nominated by the Client/Site-in-charge in this behalf.
- 2.4.9 The contractor shall provide all facilities, instruments, materials/labour required for testing the work (including checking set out of work) and shall accord site-in-charge all assistance necessary to conduct the test whenever and wherever required.
- 2.4.10 Notwithstanding anything provided in the aforesaid clause hereto, the contractor shall be and remain liable at his own cost and initiate to conduct all tests at all times during supply, erection and installation of any work/structure material or component as shall be required in terms of the contract document or by the Site-in-Charge. Such tests to be conducted through agency(ies) or laboratory(ies) shall be approved by the Site-in-Charge.
- 2.4.11 The Site-In-Charge on inspection or test be not satisfied with the quality of workmanship of any work, structure, material item or component (decision of the Site-in-charge being final in this behalf), the Contractor shall re-perform, replace, reinstall and /or re-erect as the case may be such work structure, material or component and no such rejected work, structure, material item or component shall be re-used with reference to the work, structure, material item or component shall be reused with reference to the work accepted with the prior permission of the reference to the work accepted with the prior permission of the Site-in-Charge.
- 2.4.12 Notwithstanding anything provided in aforesaid clause hereto and notwithstanding the Site-in-charge or his representative has inspected, tested and/or approved any particular work, structure, material or component, such inspection, test or approval shall not absolve the Contractor of his full responsibilities under the contract inclusive or relative to the specification, performance guarantee, the said inspection and test procedure being intended basically for satisfaction of the Client prima facie erection and/or material and equipment supplied for incorporation in the work is in order.
- 2.4.13 If on any account the Contractor proceeds with the commencing of other work and foundation and superstructure by covering up or otherwise, before necessary inspection entries are filled in the Site inspection Register by the Sit-in-charge or his authorized representative, the same shall be uncovered at the Contractors risk and expense for carrying out the inspection and measurement.

2.5 INSURANCE REQUIRED

- 2.5.1 Contractor shall also provide and maintain any and all other insurance which may be required under any law or regulations from time to time. He shall also carry and maintain any other insurance which may be required by the Client.
- 2.5.2 The aforesaid insurance policy/policies shall provide that they shall not be cancelled till the Client / Site-in-charge has agreed to their cancellation.
- 2.5.3 The Contractor shall satisfy to the Client / Site-in-Charge from time to time that he has taken out all insurance policies referred to above and has paid the necessary premium for keeping the policies alive till the expiry of the defects liability period.
- 2.5.4 The contractor shall ensure that similar insurance policies are taken out by his subcontractor (if any) and shall be responsible for any claims or losses to the Client resulting from their failure to obtain adequate insurance protections in connection thereof. The contractor shall produce or cause to be proceed by his sub-contractor (if any) as the case may be, the relevant policy or policies and premium receipts as and when required by the Client /Site-in-Charge.

2.6 SITE SUPERVISION/FACILITIES AND WORK AT NIGHT

- 2.6.1 The entire work will be carried out under the supervision of the authorized representative of the Client, but this will not absolve the Contractors from his responsibilities for quality/period of execution of the work.
- 2.6.2 The successful tenderer shall arrange for at least one competent supervisor to be present at site at all times during the progress of the work and shall be duly authorized to take instructions and execute them on his behalf.
- 2.6.3 In absence of required supervision, ALL shall engage supervisors after due notification /intimation. Supervision charges shall be debited against the Contractors immediate RA bill.
- 2.6.4 In the event that the Contractor's "Scope of Work" does not include 'erection" the Contractor will be required to provide supervisory services for the satisfactory erection, installation, testing and commissioning of the equipment/materials supplied by him. Contractor's supervisory services shall be requisitioned by the Client as and when required, on "per diem" basis during erection, installation, testing and commissioning. The contractor will be intimated in advance regarding the time and likely duration of the erection. Testing and commissioning of the respective equipment/material(s). it will be the duty of the contractor to depute his competent supervisory staff who will act independently on behalf of the Contractor. The supervision service will be deemed as "part and parcel" of the fabrication and supply contract. During the contractor's supervision at site necessary tools, tackles, implements, labour etc., will be provided. However, to maintain uninterrupted progress of work, Contractor's supervisor will prepare a Schedule and forward to the Site-in-Charge in writing sufficiently in advance.
- 2.6.5 In case the scope of work calls for working in pre-defined planned shutdowns, the Contractor shall prepare detailed programmed and shall deploy additional workman, supervisor, tools & tackles, machinery etc. along with additional project manager and safety supervisor throughout the working time including night shift, so as to complete the work as per plan.
- 2.6.6 If the Progress of the work is not up to the expectation / planned level of the Client, the Contractor shall be intimated to reinforce resources or work extra hours to cover / compensate the time loss. No additional claim shall be accepted by Client for this reinforcement or extra working hours. If the progress of work is still not satisfactory, Client shall advise the Contractor to enact to the shortfall. In case of failure to enact effectively, Client reserves the right to curtail the scope / annul the Contract. The curtailment shall be with a 15 days' notice to the Contractor to arrange appropriate Corrective Action. The annulment shall be done in case the Contractor fails to act effectively to the notice. The completed work according to Measurement sheets / SOR shall only be paid in such circumstances.

2.7 SAFETY / SECURITY OF EQUIPMENT / PROPERTY

- 2.7.1 The responsibility for the safety, security of the components, materials, equipment brought or installed by the contractor or handed over to him by the Client for completion of the work will remain with him till acceptance of the work by the Client. Any damage caused to the material/equipment during the execution of the work will be made good by the contractor to have a guarantee /indemnity bond executed for the value of the material supplied to him free of cost as per the terms of agreement.
- 2.7.2 The contractor should ensure the safety of adjoining property and shall prevent any loss to product/ property resulting from his negligence.

2.8 DISMANTLING/DAMAGE TO PROPERTY

- 2.8.1 During execution of work if it is found necessary to dismantle a portion of existing bund wall, enclosure wall, compound wall, fencing, etc. to facilitate the movement of materials and equipment, the same shall be carried out after obtaining permission in writing from
- 2.8.2 Client's authorized representative and shall also be made good by the contractor at his own cost.
- 2.8.3 Any material obtained by the contractor consequent upon dismantling of any building, structure or construction whatsoever at the job site other than any building, structure or construction dismantled by the contractor pursuant to the contractor's liabilities for defects as elsewhere herein provided, shall be exclusive property of the Client.
- 2.8.4 Contractor shall be responsible for making good to the satisfaction of the Client any loss of and any damage to all structures and properties belonging to the Client any loss of any damage to all structures and properties belonging to the Client or being executed or procured or being procured by the Client or of other agencies within the premises of all the work of the Client, if such loss or damage is due to fault and/or the negligence or wilful acts of omission of the contractor, his employees, agents representative or subcontractor.
- 2.8.5 The Contractor shall indemnify and keep the Client harmless of all claims for damage to property other than Client's property arising under or by reason of this agreement, if such claims results from the fault and/or negligence or wilful acts or omissions of the Contractor, his employees, agents, representative or sub-contractor.

2.9 WORKING CONDITIONS-SAFETY CODE

GENERAL

- 2.9.1 Contractor shall adhere to safe construction practice and guard against hazardous and unsafe working conditions and shall comply with Client's safety rules as set forth herein.
- 2.9.2 First aid and Industrial Injuries: Contractor shall maintain first aid facilities for its employees and those of its sub-contractors.
- 2.9.3 Contractor shall make outside arrangements for ambulance or suitable service and for the treatment of industrial injuries. Names of those providing these services shall be furnished to Site-in-Charge prior to start of construction, and their telephone numbers shall be prominently posted in Contractor's field Office.
- 2.9.4 All critical industrial injuries shall be reported promptly to Site-in-Charge, and a copy of Contractor's report covering each personal injury requiring the report covering each personal injury requiring the attention of a physician shall be furnished to Client.

GENERAL RULES

- 2.9.5 Carrying/striking of matches, lighters and smokers inside the hazardous area, is strictly prohibited. Violators of the No Smoking Rules shall be discharged immediately. Within the operation area, no hot work shall be permitted without valid gas/safety/fire permits issued by the Client. The contractor shall be held liable and responsible for all lapses of his sub-contractor's employees in this regard.
- 2.9.6 Contractors Barricades: Contractor shall erect and maintain barricades required in connection with his operations to guard to protect:
- i. Excavations.
 - ii. Hoisting areas
 - iii. Areas adjacent by contractor's or Clients inspectors
 - iv. Client's existing property liable to damage by contractor's operations, in the opinion of Client/site-in-charge.
- 2.9.7 Contractor's employees and those of his sub-contractors shall become acquired with Client's barricading practice and shall respect the provisions thereof.
- 2.9.8 Barricades and hazardous areas adjacent to but not located in normal routes of travel shall not be marked by red flasher lanterns at night.

SCAFFOLDING:

- 2.9.9 Suitable scaffoldings shall be provided for workmen for all works that cannot safely be done from the ground or from solid constructions except such short period work, as can be done safely from ladders. When a ladder is used, an extra worker shall be engaged for holding the ladder and if the ladder is used for carrying materials as well as suitable foot-holds and hand-holds shall be provided on the ladder and the ladder shall be given an inclination not steeper than 1 in 4 (a horizontal and 4 vertical).
- 2.9.10 Scaffolding or staging more than 30 cm above the ground or floor swing or suspended from an overhead support or erected with stationary support shall have a guard rail properly attached, bolted braced and otherwise rewarded at least 1 m high above the floor or platform of scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery materials. Such scaffoldings or staging shall be so fastened, as to prevent it from swaying from the building structure.
- 2.9.11 Working platform, gangways and stairways should be so constructed that they should not sag unduly or unequally and if the height of the platform or the gangway or the stairway is more than 30 cm above ground level or floor level, they should be closely boarded, should have adequate width and should be suitably fastened as described above.
- 2.9.12 Every opening in the floor of a building or in a working platform be provided with suitable beam to prevent the fall of persons or materials by providing suitable fencing or failing whose minimum height shall be 1 meter.
- 2.9.13 Safe means of access shall be provided to all working platform and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 10 meter in lengths, while the width between the side rails in ring ladder shall in no case be less than 30 cm for ladder up to and including 3 meters in length. For longer ladders this width should be increased by at least 6mm for spacing shall not exceed 15 cm. adequate precautions shall be taken to prevent danger from the electrical equipment. No material on any of the site of work shall be so staked or placed as to cause danger or inconvenience to any person or public. The contractor shall also provide all necessary fencing and lights to protect the workers and staff from accidents, and shall be bound to bear the expenses of defence of every suit, action or other proceedings, at law that may be brought by any person for injury sustained owing to negligence of the above precautions and to pay damages and costs which may be awarded in any such suit or action or proceedings to any such persons, or which may be with the consent of the contractor be paid to compromises any claim by such person.

EXCAVATION AND TRENCHING

- 2.9.14 All trenches 1.3 meter or more in depth shall all times be supplied with at least one ladder for each 33-meter length of trench or fraction thereof.
- 2.9.15 Ladder shall be extended from bottom of the trench to at least 1 meter above the surface of the ground. The side of the trenches which are 1.5 meter or more in depth shall be stepped back to give suitable slope or securely held by timber bracing, so as to avoid the danger of sides to collapse. The excavated material shall not be placed within 45 cm of the edge of the trench or half of the trench depth whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

SAFETY EQUIPMENT

- 2.9.16 All necessary personal safety equipment as considered adequately by the Site-in-Charge should be made available for the use to the persons employed on the site and maintained in a condition suitable for immediate use, and the Contractor should take adequate steps to ensure proper use of equipment by those concerned.
- 2.9.17 Those engaged in welding and cutting works shall be provided with protective face and eye-shields, hand gloves etc.
- 2.9.18 Hot work should be carried out only in the areas earmarked for the purpose after taking required safety precautions and only after obtaining written permission form the Site-in-Charge. Any provision required to be made e.g. wind screens of G.I sheets etc. to make the area safe for hot work, will be made by the successful tendered at his own cost.

RISKY PLACES

- 2.9.19 When the work is done near any place where there is a risk of drowning all necessary safety equipment shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision should be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

HOISTING EQUIPMENT

- 2.9.20 All the lifting tools and tackles shall be tested from competitive authority as per local Factory Rules.
- 2.9.21 Use of hoisting machine and tackle including their attachments, anchorage and supports shall conform to the following standards or conditions.
- 2.9.22 These shall be of good mechanical construction, sound materials, adequate strength free from patent defect and shall be kept in good conditions and in good working order.
- 2.9.23 Every rope used in hoisting or lowering materials or as a means of suspension shall be durable quality and adequate strength and free from patent defects.
- 2.9.24 Every crane driver of hoisting appliance operator shall be properly qualified and no person under the age of 21 years should be in charge of any hoisting machine including any scaffolding, winch or give signals to the operator.
- 2.9.25 In case of every hoisting machine and of every chain ring hook, shackle swivel and pulley block used in hoisting or lowering or as means of suspension the safe working load shall be ascertained by adequate means. Every hoisting machine and all gear referred to above shall be plainly marked with the safe working load and the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.
- 2.9.26 In case of departmental machine, the safe working load shall be notified by the Site-in-Charge. As regards, Contractor's machines, the Contractor shall notify the safe working load of the machine to the Site-in-Charge, whenever he brings any machinery to site of work and get it verified by the Site-In-Charge, concerned.

ELECTRICAL EQUIPMENT

- 2.9.27 Motors, gear transmission, electric wiring and other dangerous parts of hoisting appliances shall be provided with efficient safeguards. Hoisting appliances should be provided with such means as will reduce to the minimum the risk of accidental descent of the load; adequate precautions shall be taken to reduce to the minimum the risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations which are already energized, insulation mats, wearing apparel, such as gloves and boots as may be necessary shall be provided. The workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

MAINTENANCE OF SAFETY DEVICES AND TOOLS.

- 2.9.28 All scaffolding, ladders and other safety devices mentioned or described herein shall be maintained in safe conditions and no scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities should be provided at or near place or work.
- 2.9.29 Each tool and tackle shall be clearly marked with its size and purpose. Each set of tools and tackles shall be suitably arranged in fitted boxes of mild steel construction; the number of boxes being determined in relation to the layout of the plant in question. The taps, stocks and dies shall be kept in approved mild steel boxes with compartments for individual items. If the weight of any box and its contents is such that it cannot be conveniently carried, it shall be supplied on steerable rubber-tired wheels.
- 2.9.30 Each tool box shall be provided with a lock and two keys and shall be painted navy blue and clearly marked, in white letters, with the name of the equipment, plant or system.
- 2.9.31 The tools and tackles with the appropriate boxes, are to be handed over to the OWNER/EMPLOYER at the time of issue of the taking-over certificate.

DISPLAY OF SAFETY INSTRUCTION

- 2.9.32 Safety provisions should be brought to the notice of all concerned by display on a notice board at a prominent place at the work-spot. The person responsible for compliance of the safety code shall be named therein by the Contractor.

INSPECTION AND MONITORING

- 2.9.33 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the Contractor shall be open to inspection by the Site-in-Charge.

NO EXEMPTION

- 2.9.34 Notwithstanding the above Clauses 2, there is nothing in these to exempt the Contractor from the operations of any ACT or rules in force.
- 2.9.35 The works throughout including any temporary work shall be carried out in such a manner as not to interfere in any way whatsoever with the traffic on any roads or footpaths, at the site or in the vicinity thereto or any existing works, whether on the property of a third party.

2.9.36 No men/material equipment not covered by valid passes shall be permitted within the Project area and no material/equipment shall be permitted to be taken out of the Project area, unless authorized by the concerned authorities of the Project. The Contractor shall be held fully responsible for any or all delays/looses/damages that may result consequent on any lapse that may occur on the part of his sub-Contractors/employees in this regard.

2.10 MISCONDUCT / MISBEHAVIOUR OF CONTRACTORS EMPLOYEES

2.10.1 The Contractor is expected to co-operate/co-ordinate with other Contractors carrying out work allocated to them so as to avoid breaking up of work already done by them or causing any hindrance in the progress of their work. In case there is any difficulty/dispute the same should be immediately brought to the notice of the Site-in-Charge.

2.10.2 If an whenever the Contractors or Sub-Contractors employees, shall in the opinion of the Site-In-Charge be guilty of any misconduct of misbehaviour the Contractor if so directed by the Site-in-Charge shall at once, remove such person/persons from the employment.

2.11 PATENTS, ROYALTIES AND CONFIDENTIAL INFORMATION

If any requirement, machinery or material to be used or supplied or method of processes to be practices or employed in the performance of the Contractor is/are covered by a patent under which the Contractor is not licensed, the Contractor shall before supplying of using the equipment, machinery, materials, methods, processes, as the case may be, obtain such license (s) and pay such royalty (ies) and license fee (s) as may be necessary in connection with the performance of the contract. In the event that the Contractor fails to pay such royalty or obtain such license, the Contractor will defend at his own expense any suit for infringement of patent, which is brought against the Contractor to the Client, as a result of the failure, and shall pay any damage and costs awarded in such a suit and will keep the Client indemnified from the against all other consequences thereof.

2.11.1 Any information/drawing/specification data sheet/schedule provided to the contractor by Client in relation to this contract shall be regarded as confidential and Contractor shall not pass any of them to a third party without the Client's written consent. On completion of work, contractor will return all papers /documents / drawings and any such other material that may be construed as confidential information, to Client. The Contractor shall also undertake not to disclose any information related to the Contract and /or the Client to any party unless it is required to do so for the performance of the Contract.

2.11.2 The successful tenderer shall not sublet or assign any part of the work to another party without prior written consent of the Client. In any event, the successful tenderer will be solely responsible for the work so sublet or assigned.

2.12 DEFECT LIABILITY PERIOD

2.12.1 The Contractor shall guarantee the work done and any bought-out items supplied against defect, poor workmanship, improper design and failure from normal usage, for a period mentioned in tender Vol-I.

GUARANTEE PERIOD, REPLACEMENT OF DEFECTIVE PARTS

2.12.2 PERFORMANCE GUARANTEE

The Contractor shall guarantee the work done and any supplied bought-out items against defect, poor workmanship, improper design and failure from normal usage, for a period of 12 (twelve) calendar months after being placed in service/operation or 18 (eighteen) calendar months after final acceptance of the work by the Client, whichever is earlier.

2.12.3 WARRANTY

The Contractor will repair and/or replace all defective parts/components/fitting/ accessories etc., which shall be notified to him in writing the "Guarantee Period" immediately on notification to the Contractor in writing by the Client. The Contractor shall provide similar warranty on the parts, components, fittings, accessories etc, so repaired and/or replaced.

2.13 WELDING

Welding of steel plates and other structures and accessories shall be carried out in accordance with approved procedures by qualified welders/ welding operators.

2.13.1 Welding Responsibility

The bidder is responsible for the welding done by welders employed by him. Tests required qualifying welding procedure and to qualify the welders and if, necessary qualification of welders and welding operators shall be conducted with the approval of the Engineer-in-Charge of DEC.

2.13.2 Welding Qualifications

Qualification for welding procedures and welders shall be in accordance with the requirements of ASME Code Section IX.

2.14 CALIBRATION

All instruments used for critical measurement such as pressure gauges for leak tests, instruments for measuring performance parameters; instruments for precision dimension measurements shall have valid calibration certificates traceable to national standards. This means that the calibrating agency engaged by the CONTRACTOR shall use instruments which are in turn calibrated by Government approved agencies and such information shall be recorded in the calibration certificate issued by the calibrating agency by giving the certificate number, date and date of validity of the certificate given by the Government approved agency.

2.15 PAINTING

2.15.1 The equipment supplied by the contractor shall be finished and painted with approved shade/colour of paint. Any damage shall also be repaired and Touch Up shall be done to the satisfaction of CLIENT.

2.15.2 The Contractor shall clean and prepare the surfaces as per SA 2 ½ sand blasting and then apply primer with 2 coat of zinc chromate primer (conforming to IS: 2074) with minimum dry film thickness (DFT) 40 microns per coat and final finish of 2 coats of synthetic enamel (conforming to IS: 2932) with minimum DFT 30 microns per coat, thus having total DFT 140 microns minimum for all uninsulated pipes.

2.15.3 The Contractor shall clean and prepare the surfaces as per SA 2 ½ sand blasting and then apply primer with 2 coat of zinc chromate primer (conforming to IS: 2074) with minimum dry film thickness (DFT) 40 microns per coat for Insulated pipes

2.15.4 For galvanized pipes after welding, wherever zinc coating gets dissolved, epoxy paint shall be provided to avoid corrosion. All galvanized piping shall be painted with one coat of zinc chromate primer (DFT 25 microns) and two coats of Aluminium paint with 25 microns DFT per coat or as approved by CLIENT, thus Total DFT 75 microns minimum.

2.16 PERFORMANCE / FAILURE OF CONTRACTOR

2.16.1 If the performance of the successful tenderer is found to be unsatisfactory, the company reserves the right to cancel in part or whole of the contract and gets the work executed through alternate means at the entire risk and cost of the successful tenderer.

2.16.2 The successful tenderer shall not consider independently, any change in specifications mentioned in the tender documents. In case of doubt he will refer the matter in writing to the Client/Site-In-Charge and act as per clarifications given by the Client/Site-in-charge. Any change in the work involving changes in original specifications quantities /additional items of work, should be covered by obtaining suitable variation order (s) from the Client/site in charge immediately.

- 2.16.3 If the contractor after receipt of written notice from the Site-in-charge requiring compliance within 7 days fails to carry out and execute any work in accordance with this contract and or to comply with Site-in-charge's instructions then the Client with the consent and may employ and pay other persons to execute any such work whatsoever that may be necessary to give effect thereto, and all costs incurred in connection there with shall be recoverable from the Contractor by the Client as a debit and may at the option of the Client be deducted from any money due to or to become due to the Contractor.
- 2.16.4 Performance tests shall be carried out as per relevant / mutually agreed / specified Codes and Standards. These tests may repeat the tests carried out at the MANUFACTURER's works and/or his SUB-VENDOR / SUB-CONTRACTOR's works and any other tests the ENGINEER may require in order to determine that the equipment is in accordance with the specification and guarantees.
- 2.16.5 A programme and write-up on 'Procedure for conducting the performance tests' shall be submitted by the Contractor to the Engineer In charge for approval, at least thirty (30) days before the commencement of the tests.
- 2.16.6 Performance tests shall be conducted by the CONTRACTOR on plant/equipment supplied by him. The CONTRACTOR at his own expense, shall make all preparations, furnish testing equipment and testing personnel and incur all expenses with such tests. The date for such performance tests shall be mutually agreed upon by CLIENT and CONTRACTOR.
- 2.16.7 If the CONTRACTOR so desires, the equipment may be run for a reasonable time, immediately before the performance test is conducted. A request for this run, stating duration and operating point must be made, in writing to the Engineer In Charge at least seven (7) days before the performance test.
- 2.16.8 During any performance and efficiency test, the plant shall be operated by the CLIENT's staff under the direction of the CONTRACTOR's representative, but under the general supervision of the ENGINEER IN CHARGE.
- 2.16.9 Test shall be carried out at steady state condition and at nearly the load point. The test may be conducted at convenient time of the day or night, when the condition can be held steady.
- 2.16.10 The plant / equipment shall be continuously operated at full load for at least seventy-two (72) hours to prove its performance. For the period of the test, the time of operation shall be counted. Minor interruptions, not exceeding four (4) hours, attributable to the CONTRACTOR are acceptable. However, the test shall be prolonged for such periods of interruptions. If the interruptions are more than four (4) hours, the CONTRACTOR shall repeat the test for the full period of seventy-two (72) hours. If the interruptions are not attributable to CONTRACTOR, and the period of such interruptions is less than twelve (12) hours, the test shall be prolonged for such period of interruptions. If the interruptions not attributable to the CONTRACTOR exceed twelve (12) hours, the test shall be prolonged for a period of twelve (12) hours only. Further if the interruptions not attributable to the CONTRACTOR occur after sixty-five (65) hours of effective test period, the TENDERER / CONTRACTOR need not carry out the test thereafter.
- 2.16.11 In case the test conditions deviate from design values, the results of performance tests shall be correlated to the specified conditions by correction factors, which shall be defined by means of correction curves. These correction curves shall be submitted with the Bid and shall be reproduced and incorporated in the operating and maintenance manuals. Each correction curve must have a minimum range from 15% below to 15% above the specified conditions.
- 2.16.12 Should any Plant or equipment or any portion thereof fail, under the tests, to give the guaranteed performance, the CONTRACTOR shall be given the option of making rectification / correction after which the tests shall be repeated at the CONTRACTOR's expense. The repeat tests shall be carried out within 21 days or such extension of time as may be allowed by the ENGINEER IN CHARGE to remedy the deficiencies. All expenses for the modifications in the equipment shall be done by the Contractor, who shall have no right to claim the same from CLIENT.
- 2.16.13 The values used in the performance calculations shall be the arithmetic average (or as otherwise agreed upon) of the observations made and recorded for the agreed test period.
- 2.16.14 After the results of the performance tests have been submitted to and approved by the ENGINEER IN CHARGE, a summary of the test readings and the performance calculations shall be incorporated in the final version of the Operating and Maintenance Instruction Manuals.

- 2.16.15 Any damages / breakages during the trial operation shall be repaired / replaced by the CONTRACTOR at no additional cost. This has to be done with the written approval from ENGINEER and, if so advised by the ENGINEER IN CHARGE, the performance tests shall be repeated.
- 2.16.16 The CLIENT reserves the right to carry out further tests to check the performance and efficiency of the plant at the end of the guarantee period. The Contractor will be notified so that he can be present, if he so desires. Such adjustments to the plant as may be considered part of normal operating routine shall be carried out prior to these tests. Should the results of such repeat tests carried out by the CLIENT indicate that performance values deviate from guaranteed values within permissible units, then the CONTRACTOR shall be given the opportunity to take corrective measures and carry out further test, all at his own expense. Should the test indicate performance values below and auxiliary power consumption values above guaranteed value then a reduction in the Contract Price may be claimed by the CLIENT

2.17 TERMINATION OF CONTRACT BY THE CLIENT

- 2.17.1 The Client may terminate the contract at any stage of the construction for reasons to be recorded in the letter of termination. The Client inter alia may terminate the Contract for any or all of the following reasons that the contractor
- 2.17.2 Has abandoned the work/Contract.
- 2.17.3 Has failed to commence the works or has without any lawful excuse under these conditions suspended the work for 15 consecutive days.
- 2.17.4 Has failed to remove materials from the site or to pull down and replace the work within 15 days after receiving from the Client / Site-in-charge written notice that the said materials or work were condemned and/or rejected by the Engineer under specified conditions.
- 2.17.5 Has neglected or failed to observe and perform all or any of the term's acts, matters or things under this Contract to be observed and performed by the Contractor.
- 2.17.6 Has to the detriment of good workmanship or in defiance of the Client's / Site-in-charge's instructions to the contrary sub-let any part of the Contract.
- 2.17.7 Has acted in any manner to the detrimental interest, reputation, dignity, name or prestige of the Client.
- 2.17.8 Has stopped attending to work without any prior notice and prior permission for a period of 15 days.
- 2.17.9 Has become untraceable.
- 2.17.10 Has without authority acted in violation of the terms and conditions of this contract and has committed breach of terms of the contract in best judgment of the Client.
- 2.17.11 Has been declared insolvent/bankrupt.
- 2.17.12 In the event of sudden death of the Contractor.

2.18 LEGEND PLATES

Each supplied equipment shall be provided with a nomenclature name plate / Tag / name printing soon after completion of installation.

2.19 DRAWINGS & MANUALS

- 2.19.1 Good for execution drawings shall be prepared by successful bidder and submit to consultant for approval. Submission of Hard copy of as Built drawings in 5 sets in standard size as specified by CLIENT. The soft copy of all the as built drawings shall also be submitted in software as specified by CLIENT.
- 2.19.2 Submission of Hard copy of Operation & Maintenance manual including all bought out items in 3 sets in standard size as specified by CLIENT. The soft copy of all these shall also be submitted in software as specified by CLIENT.

2.20 SPARE PARTS

- 2.20.1 The scope of work shall include supply of normal maintenance Spares required for 1-year normal maintenance. The TENDER shall submit a list of spares as proposed by him along with his offer. Any offer without spare parts list shall be liable to be rejected.
- 2.20.2 All spares and maintenance tools and tackles shall be designed to enable maintenance to be carried out in the least time and at the least cost and support resources without affecting the performance and safety aspects.
- 2.20.3 For all major equipment including pumps, drives, large valves etc., and appropriate structural steel members shall be provided for mounting various handling devices which are necessary for the dismantling and re-assembly of the equipment components during maintenance.
- 2.20.4 All the spares and maintenance tools and tackles supplied shall be new and unused.

The CONTRACTOR shall guarantee that before going out of production of spares and maintenance tools and tackles for the equipment furnished, he shall give at least 12 months advance notice to the CLIENT, so that the later may order his requirement in one lot, if he so desires.

2.21 TESTING

2.22 All metal pipes shall be tested for radiography, dye penetrant testing, flushing, cleaning, hydro/air testing, purging with inert gases, commissioning, including consumables required for same shall be included in the unit rate for erection of piping/valves/equipment. All testing shall be done as per ASME standard. Holding time of minimum 2 hrs shall be provided for hydrotest.

2.23 Plastic pipes shall be tested with water & not by air or any gas.

2.24 The plastic pipe shall be water filled gradually, surges shall be avoided.

2.25 The plastic pipes shall be tested for maximum 1 hour. Testing pressure shall be as per manufacturers recommendation.

2.26 MINOR CIVIL WORKS

Minor civil works like wall opening, jariwork, chipping of foundation, grouting of foundations and repairing of wall opening made shall be carried out at no extra cost. It is the responsibility of the contractor that all the chasing, drilling, excavation(if applicable), done for all mechanical works to be completed and the final surface of the wall / ceiling/ floor/ ground be finished as per the Architectural finishing.

2.27 COORDINATION WITH OTHER SERVICES

The Contractor shall be required to coordinate his activities with all other services such as Mechanical Piping Contractor, Electrical and Civil (Trenches, Road Crossing, and Hume Pipes etc.)

2.28 STANDARDS & CODES

All equipment and work covered under this specification shall comply with currently applicable status, regulations and safety codes in the locality where the equipment will be installed. They shall comply in all respects with the requirements of the latest editions of the codes and standards. The Contractor shall obtain prior written approval of Client. on safety regulations to be followed before taking up any fabrication, erection, dismantling, testing and commissioning work. In case of conflict between codes and standards referred to in this specification or documents enclosed with specification and requirements of this specification, the more stringent specification shall govern.

NBC, 2016	National Building Code of India
Local AHJ	All requirements of Authorities Having Jurisdiction.
BS-5308 Part-I	Specification for Polyethylene insulated cables.
IEC:	International Electro technical Commission
IEC 79	Electrical Apparatus for Explosive Gas atmosphere
IEC-332	Test on bunched wires or cables.
IEC 529	Classification of degree of protection provided by Enclosures
IEC 584-2	Thermocouple Tolerances
IEC 751	Industrial RTD Sensors.
IEC 801	Electromagnetic compatibility for industrial for industrial Process measurement and control.
ISA:	Instrument Society of America
ISO:	International Organization for Standardization.
NEC:	National Electric Code
NEMA:	National Electrical Manufacturer's Association
ICS-6	Enclosures for industrial control system
IS: 13947	Low voltage switchgear and control gear General Part-1 rules
IEC 326.	Printed Circuit Boards
IS: 277-1977	Galvanized Steel Sheet (plain & Corrugated) (Amendment-1)
IS: 655-1963	Metal Air Ducts (Amendment-2)
IS: 659-1964	Safety Code for Air-conditioning (Amendment-1)
IS: 660-1963	Safety Code for Mechanical Refrigeration

IS: 900-1992	Code of Practice for installation and Maintenance of Induction Motors. (Amendment-1)
IS: 2441-1984	Code Practice for Fixing Ceiling Covering
IS: 4894-1987	Test Code for Centrifugal Fans
IS: 5111-1993	Code of Practice and measurement Procedure for Testing Refrigerant Compressors (Amendment-1)
IS: 7613-1975	Method of Testing Panel Type Air Filters for Air-conditioning and Ventilation Purpose.
IS: 3588-1987	Specification for Electrical Axial Flow Fan
DW 142	Testing of Leakages in ducting
BS. EN 779:1998	Air filters
ANSI/ASHRAE	Gravimetric and dust procedures for 52.1/52.2:1992 testing air cleaning devices.

3. TECHNICAL PARTICULAR: HVAC SYSTEM

3.1 VARIABLE REFRIGERENT FLOW (VRF) SYSTEM

The scope of these specifications include quality assurance, design, installation, testing and commissioning of VRF based Centralized Air Conditioning System. The system shall consist of extremely compact indoor units with wired, wall mounted controller; Outdoor unit shall be horizontal discharge, three phase and latest proven technology. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 210 and bear the AHRI Certification label; alternative recognition of equally reputable institute shall be acceptable. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO). A dry air holding charge shall be provided in the indoor section. System efficiency shall meet or exceed SEER as prescribed in ECBC Norms. Refrigerant shall be R410A.

3.1.1 INDOOR UNITS

The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit in conjunction with remote or wired wall mounted controller - shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory. The indoor unit sound pressure level shall not exceed 38 dB (A) in high fan speed. These units shall be comprising of DX coil with finned copper tubes (Evaporator), Low noise design Centrifugal Fan unit with motor & belt drive package; fan unit shall have proper insulated and leak proof condensate base connected to drain piping with suitable trap and laid up to nearest drain point designed to ensure zero leakage; the fan assembly shall be dynamically balanced for low vibration and low noise type design.

Types of units proposed (Both options) shall be as under:

- i). Ceiling Mounted Cassette Type Indoor Units
- ii) Hi-Wall Indoor Units
- iii) Ductable Indoor units

Electrical power to the Indoor Units shall be 230 V / single phase/50Hz.

3.1.1.1 CASSETTE INDOOR UNITS (CORNER SUPPLY INCLUDED)

Indoor Corner Supply included Compact Cassette type having galvanized steel plate casing. The unit shall be insulated with sound absorbing thermal insulation material, Polystyrene / Polyethylene foam. The unit shall be supplied with suitable decorative panel flush with the ceiling matching interiors. The unit shall be supplied with air flow regulator, wall mounted controller, wired/wireless remote, direct drive four speed turbo fan, self closing 4 motorized vanes, heat exchanger with Cu Coil and Al fins designed for minimum air flow resistance, insulated drain pan below coil, built in drain pump, drain hose, clamp metal, washer fixing plate, sealing pads, screws, clamps, washer for hanging bracket & insulation for fitting. The unit shall be complete with pressurized drain pumping mechanism; it shall have an LED display with Status and Temperature display and operable on Remote; If available under the suppliers range for specific CFM ratings, the cassettes shall be supplied in Micro (600*600 Size) in place of Conventional large foot print Corner Cassette Design. Drain Pump Operation shall be checked for each and every cassette prior to handing over. Drain network shall full proof including required bends / traps / airlocks to be laid and checked completely by contractor for entire floors; Pump shall keep operating during sudden switch off and restart of the unit by any reason what so ever. Under no circumstances shall there be any drain leakage issues faced post installation during summer / monsoon periods at peak / part load conditions due to manufacturing / installation issues.

3.1.1.2 HI-WALL INDOOR UNITS

Slim Line Hi-Wall type Split units having Auto Louver Mode; Indoor unit shall have Hi-Gloss all fibre exteriors matching room interiors; Unit shall have a Galvanized steel back plate & insulated with sound absorbing thermal insulation material, Polystyrene / Polyethylene foam. The unit shall be supplied with wall mounted controller, wired/wireless remote, direct drive four speed turbo fan, Evaporative type heat exchanger with Cu Coil and Al fins designed for minimum air flow resistance, insulated drain pan below coil, drain hose, clamp metal, washer fixing plate, sealing pads, screws, clamps, washer for hanging bracket & insulation for fitting. Hi-Wall units shall be supplied with pumped drain system.

3.1.1.3 DUCTABLE INDOOR UNITS

Indoor (fan coil) unit shall be ceiling suspended type comprising of finned copper tubes (Evaporator), Low noise design Centrifugal Fan unit with motor & belt drive package; fan unit shall have proper insulated and leak proof condensate base connected to drain piping with suitable trap and laid up to nearest drain point designed to ensure zero leakage; the fan assembly shall be dynamically balance for low vibration and low noise type design, . The unit shall be supplied with wall mounted controller, wired/wireless remote, direct drive four speed turbo fan, Evaporative type heat exchanger with Cu Coil and Al fins designed for minimum air flow resistance, insulated drain pan below coil, drain hose, clamp metal, washer fixing plate, sealing pads, screws, clamps, washer for hanging bracket & insulation for fitting.

3.1.1.4 GENERIC SPECIFICATIONS FOR THE INDOOR UNITS

3.1.1.4.1 EVAPORATOR

The Indoor unit is of sectionalized construction of corrosion resistant heavy gauge steel, finished with enamel paint and consisting of fan section, coil and filter section, and insulated drain pan.

The unit shall be internally lined with fibreglass of adequate thickness for thermal insulation and acoustic lining. If the insulation is in damaged condition during transit or otherwise, vendor to repair with either PU foam / Phenolic foam with suitable finish.

3.1.1.4.2 COOLING COILS

DX Cooling coils shall be of fin and tube type having aluminium fins firmly bonded to copper tubes assembled in G.I. Frame. Face surface area of cooling coils should be adequate for the air quantity handled and air velocity across the coil shall not exceed as recommended for the application. Aluminium fins shall be corrugated and collared with mechanical bonding. The coil shall be three rows (or as required) deep and fin spacing is 5 fins/cm. Coil face velocity shall not exceed 450 FPM. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan preferably with two (2) drains shall be provided under the coil. In addition to the two (2) gravity drains, the indoor unit shall be provided with an integral condensate lift mechanism able to raise drain water 21 inches above the condensate pan.

In DC inverter systems, Lift mechanism shall incorporate a safety sensor system to shut down the indoor fan and the compressor in the outdoor unit in the event of high level of condensate in the drain pan.

3.1.1.4.3 EVAPORATOR FAN

Fan impellers and housing shall be fabricated with heavy gauge steel. Fan impeller shall be forward curved, multi blade type enclosed in housing and mounted on a common shaft. All rotating parts shall be statically & dynamically balanced to run on a motor with permanently lubricated bearings. Vendor to check the condition of Fan at site accordingly prior to startup and commissioning. The indoor fans shall operate on any of three (3) speeds, High, Mid, and Low.

3.1.1.4.4 EVAPORATOR MOTOR

Fan motor shall be squirrel cage totally enclosed fan cooled type of adequate capacity suitable to operate on three phases, 400/440 volts, 50 cycles AC supply. Fan motor shall be mounted on an adjustable vibration-isolating base located on the casing of the unit. Fan shall be driven directly or through standard v - belts with belt guard. The belt drive package shall be adequately designed to meet the desired design CFM.

3.1.1.4.5 FILTER

Each filter shall be HDP washable or metallic type with adequate thickness. Filter holding frame shall be designed such that leakage of air can be avoided. Velocity across filter shall not exceed 350 FPM

3.1.1.4.6 COPPER REF PIPING

The copper piping shall comply to ASTM-B-280 supplied in straight lengths (3/8") to (4 1/8") OD; and supplied as annealed coils (1/8") to (1 5/8") OD; Mfr name shall be incised at regular intervals length not exceeding 1 1/2'; the coil shall be tubed/capped prior to shipping. Coils shall be supplied along with Test Certificates. Ref Joints Quantities in the BOQ are indicative only; VRF supplier shall provide required joints for safe and smooth operation of the system. Piping shall be supported on the wall with workman like supports including but not limited to anchor fasteners used to fix SS clamps on the wall duly isolated with neoprene / adequate piping insulation layer from the clamps.

Span of each clamp when in horizontal orientation shall not exceed 1.5 meter or those minimum required to avoid any overhang or as specified by the OEM Equipment supplier. In no case wooden material shall be used for any supporting at any place. Pipes passing through walls requiring wall core cutting shall be carried out by Contractor with his own tools and tackles and further sealed with HILTI approved model no. sealant from all sides; civil contractor shall not participate in this activity what so ever. Ref Piping insulation shall be OEM supplied specified / as per BOQ and covered with UV layer on all exposed to sun insulation materials. Exposed refrigerant piping shall be covered in GI tray with cover with suitable supports.

3.1.1.4.7 DRAIN PIPING

Condensate from the evaporator unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. If specified in SOQ, the Drain piping shall be CPVC make fully malleable with thermal conductivity (equivalent or less than 4 mm Thick Nitrile equivalent insulation) multilayer composite drain pipe supplied with manufacturer recommended fittings viz. Connector / Elbow / Tee complete. If specified in SOQ, Drain piping shall be made of suitable dia. CPVC pipe of minimum 6 Kg/Sq cm. pressure rating with water tight threaded connections, leading from the room unit to a suitable drain point. Complete drain piping shall be made leak proof and water tight by means of precise installation and the use of leak proof sealant / adhesives. Insulation of drain piping by Cross linked Polymer pipe sections or roll with minimum 4 mm thickness.

3.1.2 VRF OUTDOOR UNITS

The outdoor unit shall be of Latest Technology type and of compatible with different types of indoor units (ducted, wall mounted, ceiling suspending, and four way ceiling cassette). The outdoor unit shall be able to operate with a maximum height difference of 100 feet (30 meters) and have a maximum refrigerant tubing length of 100 feet (30 meters) between indoor and outdoor units without the need for line size changes, traps or additional oil. The unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory. All the equipment shall be factory painted with two coats of a suitable enamel paint of approved colour over a rust resistant primer.

Paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the color shade of original painted surface. Fabricated base-frame for outdoor condensing unit installation at site shall be painted with anti-corrosive paint.

3.1.2.1 VRF SYSTEM OUTDOOR UNITS SPECIFICATIONS

The system selected is a modular system, with number of indoors connected to centrally located outdoor units, as per detail designing given in the tender. The outdoor units for all the system shall be air cooled type and mounted on terrace of the building. Indoor units in various areas shall be as per enclosed drawings / Bill of Quantities. The VRF technology shall be of Latest Technology type either Inverter driven compressor or Digital Scroll; In case all Compressors are not variable flow in single configuration, Ratio of Variable Flow Compressors to Constant Flow Compressors, shall be as deemed acceptable and satisfactory of the end users. If Variable Speed Inverter type design is offered, adequate measures for oil return at low speeds shall be documented in the bid. All the VRF air conditioners shall be fully factory assembled, wired, internally piped & tested. The outdoor unit shall be pre charged with first charge of R 410A refrigerant.

Additional charge shall be added as per refrigerant piping at site. All the units shall be suitable for operation with 415 V + 10%, 50 Hz + 3%, 3 Phase supply for outdoor units & 220 V + 10%, 50 Hz + 3%, 1 Phase supply for in door units. The VRF system shall provide stable, trouble free & safe operation, with flexibility of operating desired indoor units. The outdoor units must be capable of delivering exact capacity proportional to the number of indoor units switched on & the heat load in the air conditioned area. The proportional operation shall be achieved by varying speed of the compressor in the outdoor units / change in compressor configuration or capacity as per load.

Out doors units of the VRF system shall be compact air cooled type. Percentage of variable Speed compressor configuration shall be provided in data sheets. "Anti Corrosive" treatment (Blue Fins) for Al fins of Condenser Coils is mandatory. The treatment should be suitable for areas of high pollution and salt laden air. Bidder has to furnish the rated / derated capacity of the Indoor units, considering the refrigerant piping of respective outdoor units. Back up operation, in case of failure of one of the compressors of outdoor unit, for single module outdoor units or failure of one of the modules in case of multiple module outdoor units shall be possible. The VRF outdoor unit shall always be supplying at least 33% of back up operation, of the full load capacity. The outdoor units shall be suitable to operate within an ambient temperature range of +5 Deg C to + 46 Deg C, in cooling mode. The entire operation of out door units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required. Starter for the Outdoor Unit compressor shall "Direct on Line" type. Variable Flow Compressor of the unit shall start first & at the minimum frequency / capacity, to reduce the inrush current during starting. Refrigerant control in the out door unit shall be through Electronic Expansion Valve. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested. Noise level of outdoor units shall not exceed 70 dB (A) at a distance of 1.0 m from the unit. Refrigerant piping design shall be strictly as recommended by OEM/ Principal manufacturer for respective makes. Short-listed bidder shall provide refrigerant piping design with calculations to ensure that the recommended practices are not violated. Out Door Unit installation base/ support / framing shall be designed with heavy channel members duly painted with Zinc Oxide and then with corrosion proof Synthetic enamel laid on proper vibration isolation rubber pads. Two tire installations shall be submitted for channel / angle size check of consultants before fabrication.

Outdoor units shall be complete with following safety devices:

- High pressure switch
- Fan driver overload protector
- Over current relay
- Overload Protector / Digital Protector
- Fusible Plug

Unit shall be supplied with

- Installation manual
- Operation Manual
- Connection Pipes
- Clamps

Units will use R-410 as Refrigerant / Equivalent Green Refrigerant gas.

3.1.3 MICROPROCESSOR BASED CONTROL PANEL

The microprocessor based control panel shall be with digital display showing trip and status conditions; it shall have a membrane/alternate design user-friendly key board for set-point control. It shall as a minimum provide following features:

- Auto-switch off of the condenser fan when the compressor cuts off for power saving.
- Single button start and stop flexibility for the user; the sequences for start and stop shall be taken care by the controller.
- Integrated electronic temperature sensor for precise measurement and consequent control of return air temperature.
- Compressor start-up delay timer for compressor protection and increase operational life.
- Auto restart on power restoration – optional.
- In case of Digital Scroll Technology if mentioned in BOQ, the system shall have required controls and electronics integrated with operation of EEV and Compressor Scroll to ensure variable refrigerant flow as per design demand.
- Control panel must have modules or provision for connection with centralised BMS system.

Note: Above scheme of MP panel is suggestive; Bidder to provide details of their MP panel in bid for clarity of electrical interface with electrical agency.

3.1.4 CONTROLLERS FOR VRF SYSTEM

3.1.4.1 WIRED REMOTE CONTROLLER

Wired remote controller shall be supplied as standard / specified in the “Bill of Quantities”. The controller must have large crystal display screen, which displays complete operating status. The digital display must allow setting of temperature with 1 Deg C interval. Remote shall be able to individually program by timer the respective times for operation start and stop within a maximum of 72 hours. Remote must be equipped with thermostat sensor in the remote controller that will make possible more comfortable room temperature control. The remote shall be able to monitor room temperature & preset temperature by microcomputer & can select cool/ heat operation mode automatically. The remote must constantly monitor malfunctions in the system & must be equipped with a “self-diagnosis function” that let know by a message immediately when a malfunction occurs. It shall be possible to wire the remote up to 500 RMT.

3.1.4.2 WIRELESS REMOTE CONTROLLER

Wireless remote controller shall be supplied as specified in the “Bill of Quantities”. The same operation modes & settings as with wired remote controllers must be possible. Compact light receiving unit to be mounted into wall or ceiling shall be included.

Units shall be supplied with followings:

- i. Operation Manual
- ii. Installation Manual
- iii. Paper Pattern for installation
- iv. Drain hose / Clamp metal / Insulation for fitting / Sealing Pads / Clamps / Screws

3.1.5 INSTALLATION

Entire air-cooled condensing unit assembly shall be installed on HEAVY fabrication Members Zinc Oxide coated and then painted with Corrosion proof synthetic enamel; through vibration isolators and at the place as indicated in drawings. Entire Evaporator assembly shall be supported through SS rods of required mm and suspended from the slab at places indicated in the layouts as applicable.

3.1.6 TESTING

All safety controls like High Pressure cut out, Low pressure cut out, line flow switches/differential pressure switches shall be checked for their functioning and setting and record of all the settings shall be submitted to consultant/client. The procedure for testing and commissioning shall be as approved by the consultants. The contractor shall provide all testing and measuring instruments.

3.1.7 HANDING OVER - VRF SYSTEM

Following reading/ data shall be generated as a part of handing over of the CENTRAL VRF air conditioning system, apart from the handing over data for air side & indoor design conditions.

OUT DOOR UNITS

- i. Inlet temperature
- ii. Discharge pipe temperature
- iii. Suction pipe temperature
- iv. Oil pressure
- v. Condensing Pressure
- vi. Evaporating Pressure
- vii. Power supply voltage
- viii. VRF Compressor frequency
- ix. VRF Compressor current
- x. Fan operating current
- xi. Total ODU current

INDOOR UNITS

- i. Indoor unit operation – On/ off from remote
- ii. Indoor unit operation – On/ off from thermostat
- iii. Remote control presser temperature
- iv. Suction temperature
- v. Indoor liquid pipe temperature
- vi. Indoor gas pipe temperature
- vii. Electronic expansion valve opening
- viii. Fan operating current

3.1.8 PERFORMANCE REQUIREMENT OF VRF SYSTEM

Energy Efficiency/COP of the equipment must comply with requirements of ECBC (Energy Conservation building code) latest edition. Energy Efficiency/COP of the equipment must also comply with ANSI/AHRI Standard 1230. Following table indicates the required efficiencies,

Type	Size category (kW _r)	For Heating or cooling or both	
		EER	IEER
VRF Air Conditioners, Air cooled	< 40	3.28	4.36
	>= 40 and < 70	3.26	4.34
	>= 70	3.02	4.07

Reference: Above table is taken from ECBC-2017, Table no.: 5-6

3.2 HI-WALL SPLIT AIR CONDITIONERS

Hi-Wall Mount Split Units shall be remote control operated and shall be with single splits design as per the ratings and quantities provided in the bill of quantities. The units shall be ready-to-operate type and shall comprise of an Indoor unit and Outdoor Air Cooled Condensing unit connected through insulated refrigerant piping. The system shall be charged with first charge of refrigerant after proper pre-commissioning process. Single phase connection shall be provided by client at one point at Ventilation And Air Conditioning System panel. Rest of the electrical work including cabling from the panel to the indoor/outdoor Unit's electrical panel including voltage stabilizer shall be supplied, laid and installed by vendor only. The units shall be not less than 5 Star Rating (as per BEE Compliance) and of one among the Approved Makes mentioned elsewhere in this Tender.

Brief Features desired in Indoor Unit

- Hi Gloss finish all fiber body
- Highly efficient air purification system to remove dust and odors from the return air.
- Four bend heat exchanger design for efficient heat transfer
- Noise level of Indoor Unit at operating speed shall not be exceeding 48 dB measured at a distance of 3 M from source.

- Operated through remote control having a LCD display, temperature set-point, sleep mode operation, On/Off timer, Real time clock, Auto-restart, filter status warning, dry mode operation (reduces the humidity without the temperature when required)

3.2.1 COPPER REFRIGERANT PIPING

The copper piping shall comply to ASTM-B-280 supplied in straight lengths manufacturer name shall be incised at regular intervals length not exceeding 1 ½'; the coil shall be tubed/capped prior to shipping. Coils shall be supplied along with Test Certificates.

3.2.2 DRAIN PIPING

Condensate from the indoor unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. Complete drain piping shall be made leak proof and water tight by means of precise installation and the use of leak proof sealant / adhesives. Brief Features desired in Outdoor Condensing Unit. Operating on single phase 230±10% V supply. Preferred Rotary Scroll compressor design for low power consumption per ton generated – not exceeding above 1.28 kW per TR. Electrolytic zinc steel sheet with antirust coated components to ensure rust free outdoor unit even in humid condition. Hydrophilic fins to improve the heating efficiency by accelerating the defrosting process. Installed of the Outdoors shall be on heavy channel supports painted with zinc oxide and then with anti-corrosive synthetic enamel paint.

3.2.3 CASING

Condenser casing shall be made of corrosion resistant heavy gauge steel finished with enamel paint. If specified it shall be epoxy painted or powder coated.

3.2.4 COMPRESSOR

Compressor shall be energy saving Scroll type Compressor (Twin or Single as per Unit rating) and shall be complete with required accessories such as pipe flanges, suction strainers, muffler, suction and discharge pressure gauges, oil heaters, oil pressure gauge, HP - LP cutout, OP cutout, pressure relief valve, overload for motor protection etc. Compressor shall be suitable to operate on 1 phase, 230 volts, 50 Hz AC supply and shall be designed to withstand voltage fluctuation of 15 %.

3.2.5 CONDENSER COIL

Condenser coil shall be of copper tubes having aluminum fins firmly bonded to tubes. Tube dia. shall be between 12.5 to 15 mm.; min. 24 g wall thickness and fin spacing shall be 5 fins per cm. Condenser coil shall be three rows deep. Each coil shall be factory tested at 21 kg. /sq.cm. test pressure. The coil shall have integral sub-cooling circuit. The air volume and coil face area shall be adequate for the capacity. Air velocity across the coil shall not exceed design requirements. If specified, the coil shall be made out of tinned copper tubes and tinned copper fins.

3.2.6 CONDENSER COOLING FANS

Fans shall be propeller axial type. One or more fans shall be provided for the required capacity.

3.2.7 CONDENSER COOLING FAN MOTOR

Fan motor shall be TEFC, squirrel cage, induction motor suitable to operate on 1 phase, 230 volts, 50 cycles, AC supply and provided with pulley, v belt set or direct drive flexible coupling with guards. Motor shall have class "B" insulation and shall be provided with weather protection.

3.2.8 INSTALLATION

Entire air-cooled condensing unit assembly shall be installed on HEAVY fabrication Members Zinc Oxide coated and then painted with Corrosion proof synthetic enamel; through vibration isolators and at the place as indicated in drawings. Entire Evaporator assembly shall be supported through SS rods of required mm and suspended from the slab at places indicated in the layouts as applicable.

3.2.9 PAINTING

All the equipment shall be factory painted with two coats of a suitable synthetic enamel paint of approved colour but after application of a Zinc Oxide first. Paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the color shade of original painted surface. Fabricated base-frame for outdoor condensing unit installation at site shall be painted first with Zinc oxide / then applied with Synthetic enamel anti-corrosive property paints of approved shade.

3.2.10 TESTING

All safety controls shall be checked for their functioning and setting and record of all the settings shall be submitted to consultant/client. The procedure for testing and commissioning shall be as approved by the consultants. The contractor shall provide all testing and measuring instruments.

3.2.11 PERFORMANCE REQUIREMENT OF UNITARY / SPLIT / PACKAGED AIR CONDITIONERS

Energy Efficiency/COP of the equipment must comply with requirements of ECBC (Energy Conservation building code) latest edition. Following table indicates the required efficiencies,

Cooling Capacity (kW _r)	Water Cooled	Air Cooled
≤ 10.5	NA	BEE 3 Star
> 10.5	3.3 EER	2.8 EER

Reference: Above table is taken from ECBC-2017, Table no.: 5-3

Cooling Capacity (kW _r)	Water Cooled	Air Cooled
≤ 10.5	NA	BEE 4 Star
> 10.5	3.7 EER	3.2 EER

Reference: Above table is taken from ECBC-2017, Table no.: 5-4

Cooling Capacity (kW _r)	Water Cooled	Air Cooled
≤ 10.5	NA	BEE 5 Star
>10.5	3.9 EER	3.4 EER

Reference: Above table is taken from ECBC-2017, Table no.: 5-5

3.3 PROPELLER TYPE EXHAUST FAN

The Scope covers Design, Manufacturing, Inspection, Testing, Packing, forwarding, Supply, and Supervision during erection, commissioning and providing Performance Guarantee of Propeller Fans of desired capacity. Construction. Nevertheless, the equipment to be supplied by the Bidder shall conform to the high standards of Engineering, design, and workmanship in all respect.

Fan shall be of approved make mentioned in Approved make, direct- drive, 4 to 6 blade type mounted on a steel mounted plate with orifice ring. Please refer tender bill of quantities for duty point and quantities as applicable.

Mounting Plate

The mounting plate shall be constructed of 12/16-gauge steel sheet, depending upon the fan size and finished with baked enamel paint of approved shade. Orifice ring shall be correctly formed by spinning or a stamping to provide easy passage of air without turbulence & to direct the air stream.

Fan Blades

Fan blades shall be constructed of aluminum or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades shall be quiet in operation and shall be statically and dynamically balanced at the factory

Shaft

Shall be of steel (EN 8), accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed through the full range of specified fan speeds.

Motor

Shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation and shall be suitable for 230/415 volts, 1/ 3 phase supply , with protection class IP 54 and shall be suitable for either horizontal or vertical service. Motor shall have IE-3 efficiency or better.

Vibration Isolation

The motor and fan assembly shall be isolated from the base with rubber-in-shear vibration isolator.

Performance Data

All fans shall be selected for the lowest operational noise level, capacity rating and power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation.

Inspection

The Client's/ Engineering Consultants Inspector shall at all times have as access to all parts of shop(s) where items are being manufactured and also shall be provided with all reasonable inspection facilities by the Bidder and his sub-supplier.

The Client's/Engineering Consultants reserve the right to Inspect any machinery, material and equipment's (here-in-after collectively called apparatus) furnished or used by the Sub-supplier under this contract and may reject any apparatus which is defective in workmanship or design or otherwise unsuitable for the use and purpose intended or which is not in accordance which the intent of the contract. The Bidder shall on demand by Client/Engineering consultants, remedy / replace at the Bidder's expenses, any such defective or unsuitable apparatus. The Bidder shall advise the Client in advance when the Equipment is ready for inspection in the Bidder's or his Sub-Supplier's works.

Tests:

Capacity of all fans shall be measured using hot wire anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

3.4 CENTRIFUGAL EXHAUST FAN**SCOPE**

The Scope covers Design, Manufacturing, Inspection, Testing, Packing, forwarding, Supply, and Supervision during erection, commissioning and providing Performance Guarantee of centrifugal Exhaust Fans of desired capacity.

It is not the intent of this specification to completely specify all the details of design and construction. Nevertheless, the equipment to be supplied by the Bidder shall conform to the high standards of Engineering, design, and workmanship in all respect.

The fan shall be industrial Centrifugal Single Inlet Single Width type. The casing shall be made of carbon steel plate in welded construction and painted with epoxy paint from inside and outside. The casing shall have flanges at inlet and outlet suitable for connecting to duct. The impeller shall be backward inclined type, statically and dynamically balanced, and supported on two self-aligning type ball bearings on one end of the shaft. The motor and bearings shall not come in the stream of air being handled by the fan. Drive shall be v-belt type, and a common base frame accommodating the fan and motor, complete with vibration isolators shall be provided.

MOTOR Fan motor shall be flame proof T.E.F.C., IP55, Squirrel Cage induction type suitable for AC 415+/- 10%, 3 phase, 50+/-5% HZ power supply with 'F' class insulation. Motor efficiency shall be as per class EFF-1. Fan motor shall be energy efficient and shall be suitable for 415 V+/-10% volts, 50+/-5% cycles, 3-phase, supply, totally enclosed fan cooled with insulation class 'F' and temperature rise limited to class B. Motors shall be specifically designed for quiet operation. Motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belt shall be oil-resistant type. Belt drive shall be provided over the drive belt.

INSPECTIONS & TESTING

The Client's/ Engineering Consultants Inspector shall at all times have access to all parts of shop(s) where items are being manufactured and also shall be provided with all reasonable inspection facilities by the Bidder and his sub-supplier. The Client's/Engineering Consultants reserve the right to inspect any machinery, material and equipment's (here-in-after collectively called apparatus) furnished or used by the Sub-supplier under this contract and may reject any apparatus which is defective in workmanship or design or otherwise unsuitable for the use and purpose intended or which is not in accordance with the intent of the contract. The Bidder shall on demand by Client/Engineering consultants, remedy / replace at the Bidder's expenses, any such defective or unsuitable apparatus. The Bidder shall advise the Client in advance when the Equipment is ready for inspection in the Bidder's or his Sub-Supplier's works.

TESTS

Capacity of all fans shall be measured using hot wire anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

3.5 AIR CURTAIN

Heavy duty air curtain consisting of an overhead mounted enclosure, controls, motors/fan assembly, discharge grill and curved inlet grill. Unit shall be in robust construction casing made out of MS-CRC powder coated.

The impeller is of aluminum or SS with powder coated construction with forward curved blades to minimize the air cutting noise. Adjustable nozzles/louvers vanes at 20°. End-to-end double bearings with high temperature synthetic lubricant to prevent bearing failure. Fan motor shall be T.E.F.C., IP55, Squirrel Cage induction type suitable for AC 415+/- 10%, 3 phase, 50 HZ power supply with 'F' class insulation. Motor efficiency shall be minimum as per IE2. Fan motor shall be energy efficient and shall be suitable for 415 V±10% volts, 50±5% cycles, 3-phase, supply, totally enclosed fan cooled with insulation class 'F' and temperature rise limited to class B. Motors shall be specifically designed for quiet operation. Motor speed shall not exceed 1440 RPM. Air Curtain Noise level from 3mtr from curtain should be Less than 65 db.

3.6 FRESH AIR UNIT

Unit Cabinet The cabinet shall be double skin type, constructed out of extruded aluminum hollow section framework and double skin panels. The frame profile shall also have coving to avoid sharp corners inside the cabinet. The panels shall be made out of 22-gauge (0.8mm) G.I sheets, powder coated on outer as side. Hinged access doors with gaskets and handles designed for air tight closing shall be provided for access to all internal equipment. Hand holes with airtight covers shall be provided for measurement of air temperatures in each section. Pressure sensor points shall be provided for measurement of static pressure of air in each section. Detailed specifications of components of the FAU shall be as follows:

Fan: Fan shall be DIDW type in G.I. construction with forward/Backward curved impeller, statically and dynamically balanced, supported on self-aligning type ball bearings on both ends of the shaft. Drive shall be V-belt type. Fan shall be selected such that max frequency of supply shall not exceed 50Hz in filter choked conditions. Proper arrangement shall be made for vibration isolation. Outlet velocity of fan shall not be more than 1800 FPM. All motor bases shall be adjustable and V-belt drives selected for 120 percent of motor power. Fan Wheels shall be keyed to the shaft and shall be designed for continuous operation at maximum rated fan speed and motor horsepower. Fan wheels and shafts shall be selected with maximum operating speed 25% below the first critical, and shall be statically and dynamically balanced assembly Fan shaft shall be solid steel, turned, ground, polished and coated with rust preventative oil. Belt shall be selected considering 150% safety margin. Fan performance shall be rated and certified in accordance with ARI Standard 430.

Fan Motor: Fan motor shall be flame proof T.E.F.C., IP55, Squirrel Cage induction type suitable for AC 415+/- 10%, 3 phase, 50 HZ power supply with 'F' class insulation. Motor efficiency shall be as per class EFF-1. Fan motor shall be energy efficient and shall be suitable for 415 V \pm 10% volts, 50 \pm 5% cycles, 3-phase, supply, totally enclosed fan cooled with insulation class 'F' and temperature rise limited to class B. Motors shall be specifically designed for quiet operation. Motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belt shall be oil-resistant type. Belt drive shall be provided over the drive belt.

Performance Data: All fans shall be selected for the lowest operating noise power levels. Capacity ratings, power consumption with operating points indicated shall be submitted and verified at the time of testing and commissioning of the installation. All technical data of fans should be as per AMCA class II accredited.

Dampers: Dampers shall be opposed blade louver type. Louvers shall be aerofoil type. The louvers and frame shall be made out of extruded aluminum and complete with suitable locking device having identified for open and close position. Dampers shall be in Low leakage(negligible) construction with all accessories. The damper blade shall be pivoted on both ends using SS304 or Brass spindles in self-lubricated bronze bushes. Stop seals shall be provided on top and bottom of the damper housing made of 16 gauge galvanized sheet steel. Outside air louvers of each of the fresh air and exhaust air systems shall prevent the entrance of rain, insects, birds and trash into the ducts. They shall be stamped and pressed out of one piece of aluminum sheet of at least 2 mm thickness. The frames shall also be made of aluminum.

3.7 ROOF EXTRACTOR FAN

The Scope covers Design, Manufacturing, Inspection, Testing, Packing, forwarding, Supply, and Supervision during erection, commissioning and providing Performance Guarantee of Roof Extractor Fans of desired capacity. It is not the intent of this specification to completely specify all the details of design and construction. Nevertheless, the equipment to be supplied by the Bidder shall conform to the high standards of Engineering, design, and workmanship in all respect.

Construction: The housing is made of heavy-gauge mild steel or galvanized steel in cylindrical shape casing, seamless double flanges at both end. Powder coated bake enamel finishing(above 60 micron). High efficiency impeller made of adjustable pitch aerofoil blades. ALU type or GRN type. Cylindrical stack with plate square base or fasing on to horizontal base, or tilted to suit the roof pitch.Rain hood as protection against adverse outdoor weather condition. is produced in mild steel or galvanized steel mounted on a horizontal square base. The rain hood is made of fiberglass for protection against adverse weather conditions. The impeller having manually adjustable pitch blades is made of PPG, PAG or pressure-casted aluminum.

Finish: Powder coated or galvanized after manufacture is normal finish on all parts.

Motor: Fan motor shall be flame proof T.E.F.C., IP55, Squirrel Cage induction type suitable for AC 415+/- 10%, 3 phase, 50 HZ power supply with 'F' class insulation. Motor efficiency shall be as per class EFF-1. Fan motor shall be energy efficient and shall be suitable for 415 V±10% volts, 50±5% cycles, 3-phase, supply, totally enclosed fan cooled with insulation class 'F' and temperature rise limited to class B. Motors shall be specifically designed for quiet operation. Motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belt shall be oil-resistant type. Belt drive shall be provided over the drive belt.

3.8 AIR DISTRIBUTION SYSTEM (DUCTING)

2.4.1 CONSTRUCTION

2.4.1.1 General

The design, construction/fabrication, supply, erection and performance of ducting shall comply, in general, with all currently applicable standards, codes, regulations and safety measures as applicable in the locality where it is to be installed. The items covered shall conform to the latest applicable American standards.

2.4.1.2 Design Parameters

Refer design parameters and limits in Section 5.1.3, for duct air velocities.

Leak testing after installation is required, Leakage Limits shall be as per Class "C" of DW – 142

2.4.1.3 Material

Ducting shall be made out of cold rolled, cold Annealed (CRCA) sheets, continuous galvanized with a Zinc coating of 150 - 180 g/m² on both sides. Sheets shall be flat and free from twists. Zinc coating shall be clean, even and free from ungalvanised spots. Sheets shall not crack or peel during bending or fabrication.

2.4.1.4 Fabrication

Fabrication should be as per IS / SMACNA Standard. Ducting shall be fabricated at factory on Pittsburg lock forming machine with slip type GI flange joints. Ducting shall be rectangular/round in cross section. As far as possible abrupt change of duct size and shape shall be avoided. In order to maintain decreased turbulence and low noise level, long radius elbow and gradual change in shape shall be adopted. All lateral joints between two ducts shall be provided with food grade Neoprene rubber gaskets to render the joints leak proof. Branch take-offs shall be arranged to cut or slice into the air streams to minimize the losses in velocity head. All bends/elbows shall have suitable vanes to guide the air streams. Standard elbows with a R/D ratio of not less than 1.25 shall be used. Where space restrictions do not permit the use of standard radius elbow with lesser R/d ratio, square elbows with a R/D ratio of not less than 1.25 shall be used. Where space restrictions do not permit the use of standard radius elbow with lesser R/d ratio, square elbows with equally spaced double thickness vanes may be used. The length of taper ducts shall be at least four times the maximum size difference between the ends. All duct pieces shall be properly aligned before connection to each other on both sides. The ducts shall be tapped 6 mm across the flanges. All flanges shall be connected to the ducts by rivets. All longitudinal and transverse joints shall be sealed by silicone RTV sealant.

2.4.1.5 Construction of Rectangular/Round Ducts

In case of GSS Ducts:

The general construction of rectangular/round ducts shall be as per IS standards for low / high-pressure ducting. Ducting sheet thickness, type of joint reinforcement and spacing of joints / reinforcement shall be selected as per IS depending on pressure class and dimension of bigger side of duct. All sides shall have same thickness. Necessary calculation for selection of duct sheet thickness and reinforcement shall be submitted.

TABLE-:- FOR STATIC PRESSURE UPTO 175 MM W.G. AND VELOCITY UPTO 2500 FPM

Dimension of Larger size of Duct (mm)	Sheet thickness	Transverse seems at joints.	Minimum bracing Angle size and maximum longitudinal spacing from joints (mm)	Round hanger's size.	Max. Spacing of supports (mm)
Up to 750	24G	TDF	Cross Bracing (see Note)	8mm	2400
751-1500	22 G	TDF	Cross Bracing (see Note)	10 mm	2400
1501 to 2200 mm	20 G	TDF	Cross Bracing (see Note)	10 mm	2400
Above 2201	18 G	TDF	-DO-	10 mm	2400

Note:

Submitting of duct manufacturing quality assurance plan required before starting manufacturing of ducts. All ducts to be machine made.

Minimum thickness of ducting sheet shall be 0.63 mm.

C – Cleats are not permitted for transverse joints.

2.4.2 Accessories

2.4.2.1 Splitters and Dampers

Splitters and volume control dampers shall be placed at all suitable points in Supply & Return duct for proportional volume control of the system. Louvers dampers shall be provided in all branches.

Splitters dampers shall consist of double thickness airfoil blades hinged at the downstream edge and fabricated out of extruded aluminium blades with suitable locking device, mounted outside the duct in accessible location.

Volume control dampers shall be multiple opposed blade type with extended lever for operation and shall be lockable.

Dampers blade edges shall have edge sealing by neoprene rubber gaskets.

2.4.2.2 Air Turning Devices

Air turning devices shall be provided at least for the first four outlet collars after fan. Turning blades shall be fabricated out of 22 S.W.G. galvanized steel sheets and equally spaced on side, runner to be riveted/bolted to duct sheets

2.4.2.3 Access Doors & Inspection Window

Access doors shall be provided in the duct work where specified or in casing on the both sides of equipment to be serviced. All access doors to be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be built-up construction structurally strong and each shall have at least two hinges. Inspection window of standard size shall be provided for inspection purpose, where specified.

2.4.2.4 Caulking (If applicable)

Where duct passes through wall, all openings between masonry and ductwork shall be neatly caulked or sealed to prevent movement of air from one space to adjoining space.

2.4.2.5 Curves & Bends

All curves, bends, offsets and other transformations shall be made for smooth and noiseless flow of air. The throat of every branch duct shall be sized to have the same velocity as in the main duct to which the branch duct is connected.

2.4.2.6 Flexible Connections

Where the duct is connected to make or discharge of fan units, a flexible connections of at least 150 mm width shall be provided. Flexible connection shall be fire resistant made of closely woven, double layer canvass or neoprene coated fiberglass. The material shall be

attached to casing by means of a steel band or collar fitting over the end of the flexible connection and bolted through angle iron frame so as to clamp securely between bands. A standard tapping shall be provided next to flexible connection to facilitate the measurement of outlet air temperature. Where ducts are connected to the wall, such connections shall be made through mild steel frames fixed to the wall through suitable shear fasteners.

2.4.2.7 Easement

Where pipe hangers or rods pass through the ducts, a tight and streamlined easement around the same shall be provided to maintain smooth flow of air.

2.4.2.8 Duct Supporting Arrangement

The duct shall be supported at maximum 2400 mm distances. The duct shall be supported by means of not less than 10mm dia. G.I. threaded tie rods and G.I.C. channels with rubber bushings angles. The G.I. support rods shall be hung from anchor fasteners to be fastened in the RCC ceiling or with care of minimum damage. The NEOPRENE rubber gasket shall be fixed in between ducts and M.S. angle. The steel rods are further fastened with the help of nut and bolts from structural members of roofing where practicable. Where ducts are to be supported from steel roof, sub-contractors shall provide cross members from purl in /truss and support the ducting from them.

In all, the duct shall not sag or vibrate due to lack of supports. All angles & rods shall be not – dip galvanized and hardware shall be chrome plated.

Additional supports wherein considered necessary by the Engineers-in-charge shall be provided. The entire supporting system shall be met with the approval of the Engineers-in-charge.

2.4.2.9 Inspection & Testing

The duct branches, elbows, etc. shall be inspected and the joints, connections are to be checked before they assembled in position. After assembly of the system shall be checked for tightness, vibration and noise due to turbulence.

After assembly the entire ducting shall be tested for leakage test with specified pressure in presence of Engineers-in-charge, as per DW143.

2.4.2.10 Ducting Measurement

The entire ducting assembly including S.A. plenums shall be measured for its running length & perimeter. The total sq.ft of finished surface area. Ducting erection/ commission shall be calculated on the basis of actual measurements taken at site in presence of engineer/ a representative of consulting Engineer/client. Payment will be based on actual surface area ducting, face areas of grilles/diffusers and dampers.

2.4.2.11 Fresh Air Intake & Exhaust Air Assembly

Both shall comprise of:

- i) Non return dampers shall be provided.
- ii) For fresh air intake EU4/G4 grade filters shall be provided.

2.4.2.12 Grilles & Diffusers

All grilles and diffusers shall be fabricated out of 1.0 mm powder coated Aluminum extruded material. All duct collars terminating on to grille or diffuser shall be given two coats of black paint for a minimum length of 300mm. Grilles and diffusers shall be selected for an aerodynamic noise power value not in excess of NC35.

Supply air jet nozzle diffusers shall be round, face flush type horizontal air diffusion pattern. The diffusers shall have ample margins, to minimize ceiling smudge. All supply & return air diffusers shall be provided with face-operated volume control dampers.

The shade of finished powder coated paint on Grilles/Diffuser shall be as approved by the client. Sample shall be submitted before approval.

2.4.3 Testing Of Ducts:

Wherever specified duct system after installation shall be tested for leakage as per DW-12. The fan and flow measuring orifice capacity shall be suitable to test entire supply/return ducting of each system. Measure leakage of duct at maximum operating pressure should be less than 1% of supply air quantity or as per limits for Class 'C' ducts as per DW-142 (0.17 litres per sec. per square meter of duct surface area for duct pressure rating of 500 Pascal). Whichever is higher.

The duct system shall be tested by smoke test after connection with ECU and terminals and installation of all accessories are completed to find gross leak points for rectification.

Design Parameters and Limit

a)	Duct Air Flow Velocities	
	Main supply & Return Air ducts	: 2200 – 2500 FPM
	Main branches	: 2000 – 2200 FPM
	Branch ducts	: 1000 – 2000 FPM
	Branches to air terminals	: 500 – 1000 FPM
b)	Noise Level	
	NC rating of Diffusers / Grilles	:35dB Max

2.4.4 THERMAL INSULATION

The insulation contract includes supply of all necessary insulating materials, with accessories including scaffolding/weather protection etc. as specified in this specification at the works side.

The Contractor shall supply and install the insulating materials on the Respective surfaces as described in these specifications.

The Contractor shall supply all necessary skilled and unskilled labor and supervision required for carrying out the installation as per these specifications and good engineering practice.

The insulation applications details specified herein need not necessarily be conclusive. Any additional information or deviation from these specifications to proposed practices of insulation application shall be brought to the notice of the Owner / Consultant and concurrence shall be obtained. Sketches, details and diagrams for removable housings, insulation supports, flashing details, expansion joints etc shall support these.

This specification covers design and material requirements for above ground, external insulation of piping, Ducting and equipment operating between ambient temperature and – 25°C for the purpose of heat conservation, process stabilization, temperature maintenance, personnel protection.

The insulation work covered under this specification falls under the following categories:

Thermal insulation for duct and cold service insulation for pipelines (IS7240-1990)

Insulation for personnel protection.

2.4.4.1 Purpose

Cold temperature insulation shall be installed on piping, ducting and equipment to conserve refrigeration/ cooling. Insulation thickness shall be such as to avoid condensation on the external surface.

2.4.4.2 Equipment's & Services to Be Provided

To supply & delivery to site and apply thermal insulation for ducting and piping and satisfactorily hand over whole system as per attached Schedule and as specified here.

Arrange for all necessary inspection by owner/consultant/Engineer-in charge at various stages as needed.

2.4.4.3 Duct Insulation (Material as per BOQ)

- Thermal insulation on ducts shall be provided as follows:
- Clean the surface with wire brush to remove dirt, rust, etc.
- Apply 2 coats of adhesive.
- Fix insulation on the duct before adhesive dries out.
- For ducts, which are outdoor, in service floor and in accessible/ 24 G Aluminum sheet cladding / weather protection cladding as per BOQ shall finish occupied areas.
- The duct supports for all insulated ducts shall be isolated from cold duct by load bearing insulation or wooden blocks. All handles, etc. extending outside the duct insulation shall be provided with insulated covers.

3.9 ELECTRICAL POWER / CONTROL PANEL (CPRI APPROVED)

Power / Control panel comprising of main incoming switch along with outgoing feeders for all equipments. The panel will be made out of 14G CRCA sheets, duly powder coated with two coats of synthetic enamel Grey colour. Panel shall be provided with a trifoliate or engraved metal name plates mentioning the unit number. Panel shall be totally enclosed, completely weather proof (IP65), with hinged doors, neoprene gasket and suitable locking arrangement. Including Supports for Cables, Trays etc. (Panel shall be Wall / Floor Mounted) Suitable size incoming system, MCCB switch unit. Bus bar voltmeter selector switch and Indicating lights. Isolation MCCB switch unit. All in coming power & control wires/ cable of suitable size within the panel and from panel to units. including glands and termination and earthing as per specification, Suitable PVC armoured cable from main panel to motors with proper termination and required earthing for all equipments and panels. Type-II Coordination chart shall be followed.

3.10 EARTHING OF HVAC EQUIPMENT

An Earthing network system shall be installed to provide protection against faults in electrical equipment, lightning and static electricity. Earthing system shall be designed to have low impedance to the ground and current carrying capacity consistent with the fault current. Following sizing table shall be followed for earthing.

Sr. No.	Equipment	Earth Conductor
1	Main earth grid buried underground as well as along main cable routes and in substation	1#75 x 10 mm GI strip
2	Sub earth loop along cable trays inside plant building	2#50 x 6 mm GI strip
3	ALL SOCKET	2# 8 SWG GI Wire
4	Distribution Board	2# 8 SWG GI Wire
5	Machine upto 10 KW	2#1C x4 sq.mm cooper XLPE Insulated flexible cable
6	Machine 10 KW to 20 KW	2#1C x6 sq.mm cooper XLPE Insulated flexible cable
7	Machine 20 KW to 35 KW	2#1C x16 sq.mm cooper XLPE Insulated flexible cable
8	Machine 35 KW to 55 KW	2#1C x35 sq.mm cooper XLPE Insulated flexible cable
9	Machine 55KW to 75KW	2#1C x50 sq.mm cooper XLPE Insulated flexible cable
10	Machine 75KW to 110KW	2#1C x70sq.mm cooper XLPE Insulated flexible cable
11	Above 110KW	2#1C x95 sq.mm cooper XLPE Insulated flexible cable
12	Motor OR Other Equipment Up To 15KW	2# 8 SWG GI WIRE
13	Motor OR Other Equipment Up To 15KW TO 75KW	2# 25x6 GI STRIP
14	Motor OR Other Equipment Up To 75KW TO 110KW	2# 40x6 GI STRIP
15	Motor OR Other Equipment Up To 110KW TO 410KW	2# 50x6 GI STRIP

3.11 BATTERY LIMIT

VRF system and Dehumidification system:

- Single point connection to HVAC power panel shall be provided by electrical contractor.
- All the further electrical works like, HVAC power supply panel, starter, cabling, cable tray with cover, conduits etc required for electrical works shall be in HVAC contractor's scope.

All Other Areas and systems:

- Power supply with starter and all the required accessories for all the FAUs, EAU's, exhaust fans etc shall be provided by electrical contractor.

3.12 APPROVED MAKES FOR HVAC SYSTEM

SR. NO.	EQUIPMENT / MATERIAL	MAKES
1.	Variable Refrigerant Flow (VRF) System & Split Ac	Daikin/Hitachi/Toshiba
2.	Copper Pipe	Rajko / Mandev / Total Line
3.	UPVC Pipe	Supreme/Astral/Finolex
4.	Cables	Polycab / Avocab / Havells / Finolex
5.	Indicating lamps	Siemens/ABB
6.	Air circuit breaker	Siemens/ABB
7.	Moulded Case Circuit Breaker	Siemens/ABB
8.	Switch Fuse Unit	Siemens/ABB
9.	Motor Protection Circuit Breaker	Siemens/ABB
10.	Contactors	Siemens/ABB
11.	Micro controller based Motor Protection relay	Siemens/ABB
12.	Control fuse	Siemens/ABB
13.	MCB / RCCB	Siemens/ABB
14.	Terminals	Siemens/ABB
15.	Control switch	Siemens/ABB
16.	Soft Starter	Siemens/ABB
17.	Meters	Siemens/ABB
18.	Multi-function meter	Siemens/ABB
19.	Numeric relays	Siemens/ABB
20.	Annunciator	Siemens/ABB
21.	Push buttons	Siemens/ABB
22.	Exhaust fans	System air/Kruger/Nicotra
23.	Electrical Motors	Siemens/ABB
24.	Fresh air Units	Citizen/Edgetech/Zeco
25.	Air distribution products	System air / Ruskin Titus
26.	Ducting	Rolastar/Zeco
27.	GI Sheet	Essar / Jindal

NOTE

a) The Client / Architect / Consultants / PMC reserve the right to select the manufacturer or approved make from above list, no change to be permitted in this make during the execution of the contract.

ANNEXURE I - APPROVAL OF THE ENGINEER

The contractor shall have necessary license issued by licensing authority. The license shall be valid during the tenancy of the contract. The contractor shall have his own project cell for carrying out Contracts and shall have adequate qualified and experienced Engineers to carry out the job.

Complete details of the Contractor / Sub Contractor for works shall be provided with the Offer / Tender document in a separate sheet in the following format.

General Information of the Fire Protection Contractor: (MUST BE SUBMITTED ALONG WITH TECHNICAL BID)

Name of the firm: _____.

Office Address: _____.

Telephone no.

Fax no.

Mobile no.

Factory / work shop Address. _____.

Telephone no.

Fax no.

Type of organisation: _____.

Sole proprietorship./ Partnership / Private Ltd./Public Ltd.

Name of Proprietor / Partners/ Directors etc, with bio data of key persons.

Last Three years' Business turn over (with break up indicating value for supply of material).

Date of establishment.

Company registration no:

VAT - Sale tax Registration No.

Income Tax (PAN)no.

Contract License No.

Supervisor Licence No.

EPF Registration NO.

Name and address of the bankers.

Solvency of the firm:

Litigation History:

ANNEXURE II - DETAILS OF WORK EXPERIENCE

Work Order Reference.

Value of contract.

Year of execution

Name of the Client

List of similar type of project executed in last three Year.

Value of largest project ever executed for last three year. (Minimum Project Cost 150 to 200 Lacs – single Project)

List of Projects On hand.

Technical capacity (Regular Staff)

No. of Engineers with more than five years' experience:

No. of Trade technician with more than three years of experience.

Total Strength of staff.

List of equipment, tools, tackles.

Three References of Client / Architect / Consultants

ANNEXURE III- MATERIAL APPROVAL SHEET

Before the supply of any item to site the Contractor shall obtain written approval of the same from the Architect / Consultant in the format enclosed. The format shall include all information as asked by it. Relevant Literature of the item shall also be included. This shall be supplied in 2 copies.

MATERIAL APPROVAL SHEET		
PROJECT:		
CONTRACTOR: _____		
	Sheet No	(Contractor shall indicate the submittal in sequence)
	BOQ Item Reference	(To indicate the Item No as per the Tender)
	Material Description	(Short Item Description)
	Make of Item	
	Date of Submission	
	Delivery Period	
	Approvals	(Contractor to indicate approvals from IS/ NBC/ FM/ Local Fire Authorities, as necessary)
	Lead time for delivery	
	Deviation from tender	
	Literature attached	(Contractor to indicate number of pages of literature attached with each submittal)
	Signature of Contractor	
	Comments / Approval from Architect	

**ANNEXURE IV- DETAILS OF EQUIPMENTS, TOOLS TACKLES PROPOSED TO
BE DEPLOYED FOR THIS WORK**

NAME OF WORK:

NAME OF BIDDER:

DETAILS OF EQUIPMENT, TOOLS TACKLES PROPOSED TO BE DEPLOYED
FOR THIS WORK

**TENDERERS shall submit herein details of equipment, tools, tackles, etc.
proposed by him to perform the work under this contract.**

Sr. No. of Item	Description of item, of Model & Capacity	Year of Manufacture	Category Remarks	Nos/Qty
1	2	3	4	5

Contractor agrees to augment the above chart with additional number / categories of equipment, if required, to complete the work within the agreed time schedule of completion and directed by the Engineer-in-charge.

SIGNATURE OF TENDERER

ANNEXURE V- DETAILS OF MINIMUM DAILY MANPOWER PROPOSED TO BE DEPLOYED ON THIS WORK

Sr. No.	Details of Man-power	Average No. per day week wise							
		M-1	M-2	M-3	M-4	M-5	M-6	M-7	M-8
1	Fitter								
2	Helper								
3	Welder								
4	Supervisor								
5	Engineers								
6	Site Manager								
7	Safety Officer								

Minimum manpower deployment shall be based broadly as above and shall be modified as mutually agreed to suit the detailed construction programme jointly worked out. Further if any additional manpower is required for completion of work in time, the same shall be provided by the Contractor as directed by Engineer-in-charge without any extra cost.

SIGNATURE OF TENDERER

ANNEXURE VI- ORGANIZATION CHART AND LIST OF QUALIFIED

ENGINEERS & SUPERVISORY PERSONNEL ETC. PROPOSED TO BE DEPLOYED FOR THIS WORK

- a. Please enclose the organization chart on separate sheet
- b. List of key personnel

S.N.	Name	Designation	Qualification	Experience		Remarks
				Total	With the Contractor	

Name and short resume of the experience for key personnel may be enclosed in separate sheets.

The tentative chart of site organization as above furnished shall be subject to variation to suit the construction programme / requirement and as directed by the Owner / Engineer-in-charge.

SIGNATURE OF TENDERER

ANNEXURE VII- SCHEDULE OF DEVIATION

- Bidder shall submit deviations in the format given below. The deviations submitted other than the format given below shall not be considered.
- In absence of any deviation statement it will be assumed that the requirement of specification is met without any deviation.

S.N.	Clause No.	Description	Bidder's Deviation	Remarks

SIGNATURE OF TENDERER

ANNEXURE VIII- LIST OF DRAWINGS

Sr. No.	Drawing number	Drawing Title
1	MH.40B.401	HVAC Layout-CP Area
2	MH.40B.402	HVAC Layout-Roof Plan
3	MH.40B.403	HVAC Layout-Sections